

Durham Research Online

Deposited in DRO:

19 January 2010

Version of attached file:

Accepted Version

Peer-review status of attached file:

Peer-reviewed

Citation for published item:

Scolobig, A. and Castán Broto, V. and Zabala, A. (2008) 'Integrating multiple perspectives in social multicriteria evaluation of flood-mitigation alternatives : the case of Malborghetto-Valbruna.', *Environment and planning C : government and policy*, 26 (6). pp. 1143-1161.

Further information on publisher's website:

<http://dx.doi.org/10.1068/c0765s>

Publisher's copyright statement:

Additional information:

Scolobig, A. and Castán Broto, V. and Zabala, A. (2008). The definitive peer-reviewed and edited version of this article is published in *Environment and planning C : government and policy*, 26 (6), 1143-1161, doi: 10.1068/c0765s

Use policy

The full-text may be used and/or reproduced, and given to third parties in any format or medium, without prior permission or charge, for personal research or study, educational, or not-for-profit purposes provided that:

- a full bibliographic reference is made to the original source
- a [link](#) is made to the metadata record in DRO
- the full-text is not changed in any way

The full-text must not be sold in any format or medium without the formal permission of the copyright holders.

Please consult the [full DRO policy](#) for further details.

INTEGRATING MULTIPLE PERSPECTIVES IN SOCIAL MULTICRITERIA EVALUATION OF FLOOD MITIGATION SCENARIOS: THE CASE OF MALBORGHETTO-VALBRUNA

Anna Scolobig, Vanesa Castán Broto°, Aiora Zabala◇*

2007

*ISIG, Italy
Mass Emergencies Programme – PEM
Institute of International Sociology of Gorizia - ISIG
Via Mazzini, 13
34170 Gorizia (Italy)
Tel +39 0481 533632 / Fax +39 0481 532094
e-mail: annascolobig@yahoo.it

°EHS-Forest Research, Surrey
Social and Economic Research Group
Forest Research
Alice Holt lodge
GU10 4LH Farnham-Surrey (UK)
Tel +44 01420 526177
e-mail: vanesa.castan.broto@forestry.gsi.gov.uk

◇ ICTA, Institute of Environmental Science and
Technology – Barcelona
Institut de Ciència i Tecnologia Ambientals.
Edifici Ciències, Torre Àrea 9, 4a planta. C5-438
Universitat Autònoma de Barcelona
08193 Bellaterra (Spain)
Tel +34 93 581 29 74 / Fax +34 93 581 33 31
e-mail: aiora.zabala@gmail.com

The paper draws upon some preliminary results of the Project “Floodsite” (2004-2009; <http://www.floodsite.net>), funded by the European Commission within the 6th Framework Programme. Thirty six partners from thirteen European countries are involved in the project. This paper is based on research at ISIG, within task 11 “Risk perception, community behaviour and social resilience”. One of the authors, Anna Scolobig is part of the ISIG research team, coordinated by Bruna De Marchi, head of the Mass Emergencies Programme. The contents of the present paper are the responsibility of the authors alone and do not necessarily reflect the opinions of the EC. This paper was elaborated thanks to the authors' participation in the Marie Curie Summer School “Emerging Theories and Methods in Sustainability Research (THEMES)” held at the Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona, in July 2006. We thank Joan Martínez Alier, Arild Vatn and Bruna De Marchi for their valuable inputs.

INTEGRATING MULTIPLE PERSPECTIVES IN SOCIAL MULTICRITERIA EVALUATION OF FLOOD MITIGATION SCENARIOS: THE CASE OF MALBORGHETTO-VALBRUNA

Keywords

Flood mitigation, decision-making processes, social multi-criteria evaluation, qualitative social research methods, social actors' value orientations and valuation languages

Abstract

There is an increasing demand for a new paradigm to improve flood mitigation decision processes that calls for risk reduction strategies at several levels. This demand may gain ground only if dialogue is encouraged among different perspectives, disciplines and knowledge types. The aim of this paper is to explore new routes to improve flood mitigation decision processes. A growing body of evidence suggests that the involvement of all the social actors is a key aspect in successful decision making. Following this premise, this paper analyzes a recent case of controversy in flood mitigation in Malborghetto-Valbruna (Northern Italy), using Social Multi-Criteria Evaluation (SMCE) and Social Actors' Narratives Analysis. Six scenarios are defined and the different positions adopted by the local actors are described. The different narratives of the actors are also analysed to allow the identification of improvement routes for a more accurate SMCE of flood mitigation scenarios. Thus, this case study suggests that the analysis of narratives is a useful tool to complement SMCE.

1. Introduction

The emergence of sustainability problems has posed several dilemmas on the capacities of current governments to take decisions that affect simultaneously society and the environment. Muticriteria methods¹ aim at addressing the uncertainties associated to sustainability problems, by considering simultaneously several alternative descriptions of the problems (Munda, 2004) and by putting special emphasis on including additional criteria to the traditional economic ones. These methods facilitate the decision-making process representing the views of different actors, allowing the comparison between alternatives, and visualizing the trade-offs between conflicting criteria (Kiker *et al.*, 2005).

There is a growing body of evidence suggesting that successful decisions about floodplain management issues require the participation of all the social actors (Bana *et al.*, 2004; De Bruijn, 2005; Fordham, 2000; Haque *et al.*, 2002; Messner and Meyer 2006; Pearce, 2003). Some multicriteria methods have been developed to accommodate participation of stakeholders during the assessment process (e.g. Stirling, 2006). Participatory approaches to multicriteria decision-making combine the possibility of considering several alternatives simultaneously with an emphasis on the process

¹ Water policy is one of the fields in which multicriteria methods have been used extensively. On their pioneering work in the Netherlands, Nijkamp and Vos used MCA for the planning of water resources development (Nijkamp and Vos, 1977). Thereafter MCA has been applied in various flood management cases.

through which decisions are achieved (e.g. Gamboa and Munda, 2007). Some Multicriteria Analysis (henceforth MCA) applications have also been used to reach consensus among stakeholders (e.g. Hämäläinen *et al.*, 2001; Mustajoki *et al.*, 2004).

Traditional MCA methods alone prove insufficient when confronted with the dynamic nature of stakeholders perspectives, the structures of power that influence the decision making process and the variability between definitions - in our case on the flood mitigation problem. In order to overcome these limitations, MCA should be combined with other social research methods to allow a better representation of stakeholders' views and perspectives. An attempt to integrate social research methods within MCA has result in the development of Social Multicriteria Evaluation (henceforth SMCE) (De Marchi *et al.*, 2000; Gamboa, 2006; Gamboa and Munda, 2007; Janssen and Munda, 1999; Munda, 2004). In order to integrate social aspects in SMCE, different methods and techniques can be used, such as surveys, discourse based evaluation, narrative analysis, and value integration methods (e.g. in the case of flood related issues: Gregory and Wellman, 2001; Morris-Oswald and Sinclair, 2005; Simonovic, 2005).

This paper analyzes a recent case of controversy in flood mitigation in Malborghetto-Valbruna (Northern Italy) and assesses different scenarios using SMCE and social actors' narrative analysis. The simultaneous application of both methods in the case of Malborghetto-Valbruna gives some insights about their combination and the potential of qualitative research methods to further develop SMCE.

2. The Malborghetto-Valbruna case-study

Conflicts concerning safety and environmental issues are common in flood prone areas. An interesting example is the 2003 flash flood in Malborghetto-Valbruna, Northern Italy. After the flood event, decisions about mitigation measures led to a debate between advocates of hydraulic works and those proposing a management of floods based on resilience and traditional knowledge.

Malborghetto- Valbruna is a municipality in the Region of Friuli Venezia Giulia situated near Austria and Slovenia. It is located in Valcanale valley on the discharge area of the river Fella and the main streams Rio Malborghetto and Rio Uque. The entire municipality has a population of 1,026 inhabitants (Municipal Statistical Office Data, 2004) divided in 4 different hamlets: Ugovizza, Valbruna, Malborghetto and Bagni di Lusnizza.

Ugovizza and Malborghetto suffered a severe flash flood on 29 August 2003 which caused 2 casualties and extensive material damage. The flood was the result of the combination of two extreme events: an extraordinary storm, which discharged 400 mm of rainfall in a short period of three to six hours and the anomalous moisture condition of the soil, extremely dry at the end of a prolonged drought. Water transported sediments, stones, and shrubbery onto Malborghetto and Ugovizza, causing severe damage to infrastructures and property and forcing the evacuation of 600 people. The damage to the whole valley was estimated in 435 million Euros.

The recovery phase raised issues related to flood mitigation, such as decisions upon the construction of protection works in the floodplain and their maintenance, streams' and rivers' monitoring and control, floodplain zoning and regulation, and restoration of the riverine ecosystems. Arising conflicts included also disagreements among local people about the reconstruction process and the distribution of compensation payments.

One of the most discussed issue regarded the decisions about protection measures, and in particular the construction of structural devices in the most dangerous streams initiated by the regional Civil Protection². While several projects started immediately after the flood, others were delayed due to different reasons, such as expectation of funds or of a favourable geological advice, as required by flood regulations.

The construction of protection works encountered opposition from residents claiming that local authorities had not consulted the relevant interest-groups during the decision making process. They contested the decisions about the localisation and the quantity of protection works based on equity claims about hydrogeological risk distribution among residents.

A group of residents concerned with the security of their properties established a Local Committee for Safety. They demanded the construction of new hydraulic works upstream to ensure the total protection of their properties; lately the regional Civil Protection joined the Local Committee for Safety in their claims to municipal authorities. In contrast, the local political opposition party criticized the top-down technocratic procedures of the Municipality and the Civil Protection because they had failed to involve the community in the flood management process. The opposition coalition claimed that local knowledge would offer better alternatives for the flood risk mitigation such as the implementation of minor hydraulic works, the restoration of the vegetation cover and the enforcement of an adequate emergency plan. The institutional analysis presented in Table 1 identifies the social actors involved and describes their main positions.

² In Italy, the Department of Civil Protection (under the Presidency of the Council of Ministers) coordinates the Government's actions relative to forecasting, early warning, support, and rescue. Regions, Provinces and Municipalities prepare programmes for risk forecasting and prevention. At the local level, contingency plans and emergency response are co-ordinated by the Prefect, and implemented by the local Fire Brigades (which depend on the Ministry of the Interior), together with the local Civil Protection services (of the Region, Province, Municipality) (De Marchi *et. al.*, 2006).

Table 1. Social actors involved in the Malborghetto-Valbruna case study (2006)

<i>Social actor</i>	<i>Main features</i>
1. Regional Civil Protection	The Civil Protection is a civil service organization at the regional scale. Its main functions are guaranteeing the security of the population and coordinate actions relative to forecasting, early warning, support, and rescue.
2. Geologists	A group of geologists living and working in the area proposed the relocation alternative. Their perspective is an "expert" one, differentiated from engineers. In their opinion, the only solution to guarantee real safety is the relocation of some parts of the hamlet of Ugovizza.
3. Municipality of Malborghetto-Valbruna (Majority coalition)	Actions taken by the majority coalition identify the council as a technocratic organization. The Local Council is likely to hold moderate positions with respect to the construction of new hydraulic works although in practice it supports the proposals of the Civil Protection.
4. Municipal opposition coalition	The municipal opposition coalition is active at a policy level and presents proposals that move away from the technocratic orientations of the Council. They argue that local people should be widely represented in the decision-making process for flood mitigation, both in the evaluation process and in the development of innovative solutions. In their view, local knowledge can provide alternative solutions for flood mitigation such as smaller adaptive hydraulic works, natural regeneration and different land use management techniques.
5. Local residents living in high risk areas (Ugovizza hamlet)	Local residents living in Ugovizza were heavily damaged by the 2003 flood event. Their geographical location makes them the most exposed sector of the community to flood events.
6. Local residents living in medium risk areas (Malborghetto hamlet)	Local residents in Malborghetto-Valbruna suffered material damages during the 2003 flood event. The construction of new protection works has increased their concerns. In addition, they complain about the visual impacts of the new works.
7. Local Committee for Safety	The Local Committee for Safety is a local grassroots organization, created in response to the prevention and mitigation measures planned after the flood. Their members demand the construction of further hydraulic works upstream. Members of the committee are mainly "new residents", i.e. people who moved to the village in recent years. More precisely, they moved to an area of the village urbanized in the seventies and considered by local people one of the most dangerous one within the municipality. Around 100 people have signed the original statute of the committee.
8. Local voluntary fire brigades	Local voluntary fire brigades have a strong tradition in Northern Italy. Members of the brigades are local volunteers who, after training, make themselves available when an emergency occurs. Around 100 local residents are involved in three different local voluntary fire brigades corps located in Malborghetto, Ugovizza and Valbruna.
9. Environmentalists (only at a regional level)	They are present mainly at a regional level and their direct influence in the local community is limited, although it is relevant for the safety debate. Their proposals include the re-naturalization of the area and the return of the river/streams to their original beds. Given recent events these proposals are supported by very few residents.

3. Methodology

The analysis presented in this paper utilises data collected in the task 11 "Risk perception, community behaviour and social resilience" of the FLOODsite research project. The research design combined several methods and techniques (De Marchi *et al.*, 2006): firstly, data from secondary sources³ on the socio-demographic situation in the area; secondly, qualitative information was gathered through eighteen semi-structured interviews with qualified informers⁴; thirdly, statistical data was obtained through a survey with a standardized questionnaire⁵. This process was intended as a basic sequence of steps, each one providing an input to the following one. The second and third steps are the most relevant for the purpose of this paper. The interviews were planned to explore, among others, the main strengths and weaknesses of a community exposed to flood risk, and to collect information about the emergency management, the reconstruction planning, the decisions about protection measures, the existing flood mitigation scenarios, etc. In the survey, 100 residents were interviewed about their flood experience, opinions and attitudes including the most urgent measures to adopt in the floodplain, the role of structural and non structural protection measures, and the influence of different actors in the decision making process.

The findings of the interviews and the survey have been used as the starting point for this paper, and more precisely for the Social Multi-Criteria Evaluation (SMCE) and the social actors' narratives analysis. The first method allows the comparison of different scenarios or management alternatives with respect to different criteria. The second one helps exploring value dilemmas and interest conflicts with regard to flood mitigation decisions in Malborghetto-Valbruna.

4. Results from the Social Multicriteria Evaluation

4.1. Development of scenarios

The application of SMCE to a case study requires specifying scenarios and criteria. The development of scenarios is followed by the selection of relevant criteria and finally different methods are used to compare the scenarios. Scenarios and criteria can be defined directly by the experts involved in the study or by involving the local actors in developing the SMCE.

³ Socio-demographic information about gender, age, level of education, occupation rate, etc. were gathered with the support of the statistical municipal office.

⁴ Qualified informers are people who, due to their status, role or experience, have a deep knowledge of the subject under investigation and/or the relevant social context. The eighteen semi-structured interviews were conducted with the mayor, some city councillors, the head of technical and environmental department involved in area planning, the head and some members of the local fire brigades corps, chairmen of some local cultural associations, the chairman and a member of the local committee for Safety, journalists of local newspapers, and community leaders.

⁵ The questionnaire was prepared for the FLOODsite project (**Error! Hyperlink reference not valid.** and was submitted face to face by trained interviewers. It included 72 questions, mostly pre-structured, with some open questions, and covering numerous issues: community cohesion and social capital; flood risk awareness; residents' behaviours during 2003 event; opinions about damage compensations and risk insurance; level of personal and community preparedness before and after the event; attitudes toward mitigation, regulation, and constraints; personal knowledge and information about safety connected to different elements (protection works, warning systems,...); lessons learnt from the event; general information. A quota sample was selected on the basis of the following variables: gender, age, education, and risk exposure (high, medium and low risk area).

Different scenarios basically reflect different approaches to flood management and mitigation. For example, Green and colleagues (2000) identify four alternative approaches: those based in local knowledge, structural approaches, non-structural approaches, and holistic approaches.

Approaches based on local knowledge assume that communities living in flood prone areas have developed specific knowledge that allows them to develop adaptive strategies to cope with flood disasters (e.g. Rasid and Bimal, 1987).

Structural approaches are characterized by the construction of big hydraulic structures to “control” floods. Symbolically, these structures are referred to as “defences” (e.g. WCD, 2000).

Non-structural approaches emerged within integrated strategies for the management of floodplains, in combination with technocratic approaches. Later on, advocates of non-structural approaches have focused on resettlement and adaptations of existing infrastructures, arguing that human development in floodplains should be strictly limited.

Holistic approaches integrate all the other approaches within the idea of “*living with the flood hazard*”. The aim is to reduce or mitigate the risks as much as possible, by means of socio-economically viable measures. This approach emphasizes the development of warning systems and evacuation plans, as well as increasing resilience of the community by creating appropriate institutions to deal with flood management and mitigation.

On the basis of these approaches, a literature review (Bana *et al.*, 2004; De Bruijn, 2005; Fordham, 2000; Green *et al.*, 2000; Haque, 2002; Kiker *et al.*, 2005; Messner and Meyer, 2006; Schanze, 2006) and the information gathered during the fieldwork, four scenarios were identified in Malborghetto-Valbruna:

- Preservation of the current situation. This alternative assumes that no further action is to be taken for the flood mitigation, other than completing the construction of already planned protection infrastructures.
- Higher safety through the construction of new protection works. Promoted by the Local Committee for Safety, this scenario involves the construction of “bigger defence structures”, which in their opinion would ensure a higher safety level.
- Relocation of part of the community. This would result is the relocation of people currently living in the highest risk areas. For the purposes of this paper it is assumed that relocation costs will be shared among the municipality and the relocated people.
- Investment and developing of monitoring and control activities. This scenario includes measures for ensuring a better management of the territory as well as the non-structural protection measures already in place, such as early warning systems, the monitoring brigades, forest management, and an evacuation protocol.
- Integrated flood management incorporating local knowledge. This scenario aims at developing measures for flood management that take into consideration local environmental knowledge and increase resilience, emphasizing the participation of local people in the decision making process.

- Re-naturalisation. This scenario proposes the de-commissioning of existing hydraulic works in the river bed and the limitation of economic activities in the floodplain.

The fieldwork results were analysed by the authors during two brainstorm sessions to discuss the potential criteria for evaluation and their suitability to the case of Malborghetto-Valbruna. Table 2 shows the final selection of criteria, together with the needs and expectations of social actors which justify the relevance of each one. To allow the evaluation of the scenarios according to these criteria, measurable indicators were selected. Indicators allow for a comparative evaluation of the scenarios, according to the criteria selected.

Table 2. Dimensions and criteria

<i>Dimension</i>	<i>Criteria</i>	<i>Needs and expectations</i>	<i>Indicators</i>
ECONOMIC	Ec1- Economic growth and urban development	<ul style="list-style-type: none"> ▪ Promotion of the economic growth in the area ▪ Space guarantee for urban development ▪ Respect of safety standards 	<ul style="list-style-type: none"> ▪ Establishment of new buildings/industries in the floodplain
	Ec2- Economic stability and well-being	<ul style="list-style-type: none"> ▪ Increase of employment opportunities for residents ▪ Maintenance of income levels ▪ Avoidance of extraordinary costs to residents 	<ul style="list-style-type: none"> ▪ Increase of employment opportunities ▪ Maintenance of property prices and reduction of their fluctuations
	Ec3- Optimization of the technical characteristics of the flood protection works	<ul style="list-style-type: none"> ▪ Improvement of the quality of the landscape 	<ul style="list-style-type: none"> ▪ Reduction of the visual impact of flood protection works

<i>Dimension</i>	<i>Criteria</i>	<i>Needs and expectations</i>	<i>Indicators</i>
SOCIAL	So1- Community resilience	<ul style="list-style-type: none"> ▪ Reduction of community vulnerability to flood hazard ▪ Improvement of community resilience 	<ul style="list-style-type: none"> ▪ Awareness and preparation for flood events
	So2- Disruption of the social structure	<ul style="list-style-type: none"> ▪ Avoidance of conflicts between different social actors ▪ Strengthening community cohesion/integrity 	<ul style="list-style-type: none"> ▪ Potential for conflict between different groups
	So3- Community and institutional development	<ul style="list-style-type: none"> ▪ Increase of local residents' participation in decision-making ▪ Improvement of the dialogue among different social actors 	<ul style="list-style-type: none"> ▪ Community involvement in management alternatives decisions
	So4- Maintenance of the local culture	<ul style="list-style-type: none"> ▪ Reduction of the rates of emigration and abandonment of mountain areas ▪ Recover of local knowledge 	<ul style="list-style-type: none"> ▪ Integration of local knowledge in flood mitigation strategies

<i>Dimension</i>	<i>Criteria</i>	<i>Needs and expectations</i>	<i>Indicators</i>
ENVIRONMENTAL	En1- Land disruption	<ul style="list-style-type: none"> Reduction of the human appropriation of land 	<ul style="list-style-type: none"> Reduction of land occupied by human activity
	En2- Maintenance of biodiversity	<ul style="list-style-type: none"> Maintainance of the ecological diversity Preservation of flora and fauna species and their habitats 	<ul style="list-style-type: none"> Disruption of local flora and fauna
	En3- Soil conservation	<ul style="list-style-type: none"> Reduction of erosion and soil degradation Increase in the stability of hydrological processes Minimization of the potential impacts of floods on soil degradation 	<ul style="list-style-type: none"> Increase in soil erosion

4.2. Impact matrix

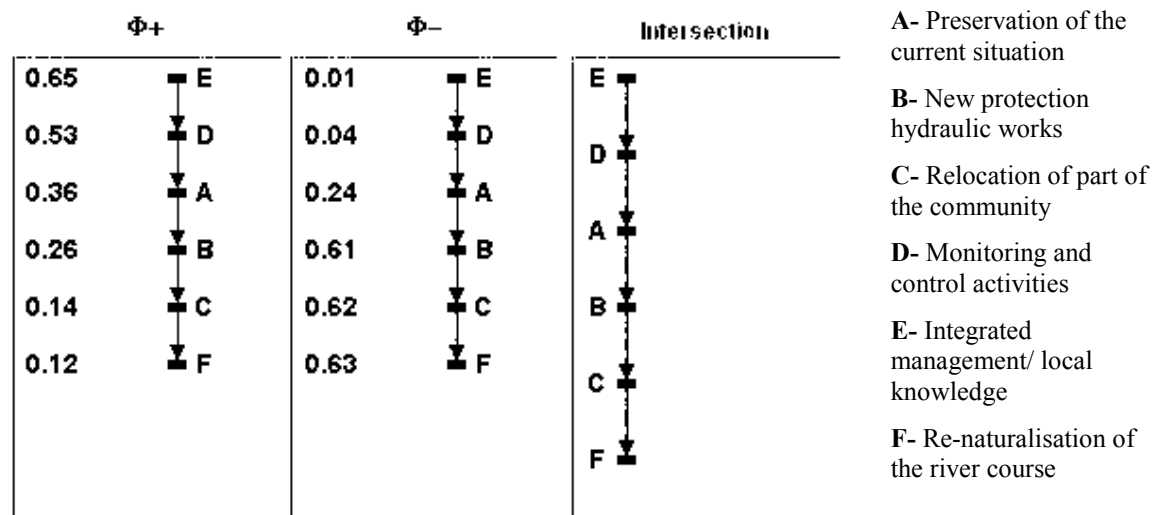
Following the selection of relevant criteria on the basis of the fieldwork, the authors ranked the scenarios for every indicator on a qualitative scale of seven ordinal categories, 7 being the most favourable result and 1 meaning the worst expected result, according to the directions derived from needs and expectations. This input was used to build the Impact Matrix shown in Table 3.

Table 3. Impact Matrix: assessment of criteria in different scenarios

SCENARIOS CRITERIA	A- Preservation of the current situation	B- New protection hydraulic works	C- Relocation of part of the community	D- Monitoring and control activities	E- Integrated management/ local knowledge	F- Re-naturalisation of the river course
Ec1- Constructions in the flood plain	*****	*****	*	****	***	**
Ec-2 Changes in property prices	****	*****	*	****	****	*
Ec2- Increase in employment opportunities	****	*****	*	*****	*****	**
Ec3- Visual impacts of flood protection works	**	*	*****	****	****	*****
So1- Awareness and preparation for flood events	***	**	*****	*****	*****	***
So2- Potential for conflict between different actors	**	***	*	****	****	*
So3- Community involvement	**	****	**	*****	*****	***
So4- Integration of local knowledge	**	*	*	*****	*****	***
En1- Reduction of land occupied by human activity	****	*	*****	***	****	*****
En2- Disruption of local flora and fauna	***	*	*****	****	*****	*****
En3- Increase in soil erosion	***	*****	*****	****	****	*****

The Impact Matrix was introduced in the NAIADE software⁶. This software allows for the aggregation of the results for each criterion using pairwise comparisons⁷. Pairs of scenarios were compared calculating preference relations (much better, better, approximately equal, equal, worse, much worse) using no weighting. The final ranking of the scenarios, in Figure 1, shows the aggregate results for all the indicators. The final ranking results from the intersection of two separate rankings, $\Phi+$ indicating how much better that scenario is than the others (aggregating the best results for each indicator), while $\Phi-$ explains how much worse that scenario is than the other options (aggregating the worse results for each indicator).

Figure 1. Ranking of scenarios



Examining the scores from the NAIADE application, we observe that scenario E (Integrated management incorporating local knowledge) and D (Investment in monitoring and control) are the most preferred ones, according to the given criteria.

The ranking results, however, cannot be interpreted in isolation and need to be compared with the impact matrix results. For instance, scenario C (Relocation of part of the community) and F (Renaturalisation of the river course) are ranked at the bottom even if both of them have the most beneficial environmental impacts. In this case all the criteria were considered to have the same importance. Had we established a weighting to prioritise the preservation of the environment, scenarios C and F could have ranked much higher.

4.3. Social Impact Matrix

Data gathered during fieldwork provided the basis for the identification of different actors, their perspectives and preferences with respect to each scenario. These inputs have been used to build the Social Impact Matrix shown in Table 4. The preferences of each actor were ranked from 1 (the least support) to 7 (the maximum support) for each scenario. The Social Impact Matrix differs from the Impact Matrix in that it shows the opinions of the actors about each scenario, instead of using criteria as a proxy for evaluation.

⁶ NAIADE (Novel Approach to Imprecise Assessment and Decision Environments) (Munda, 1995) is a multicriteria method for the comparison of alternatives on the basis of a set of criteria.

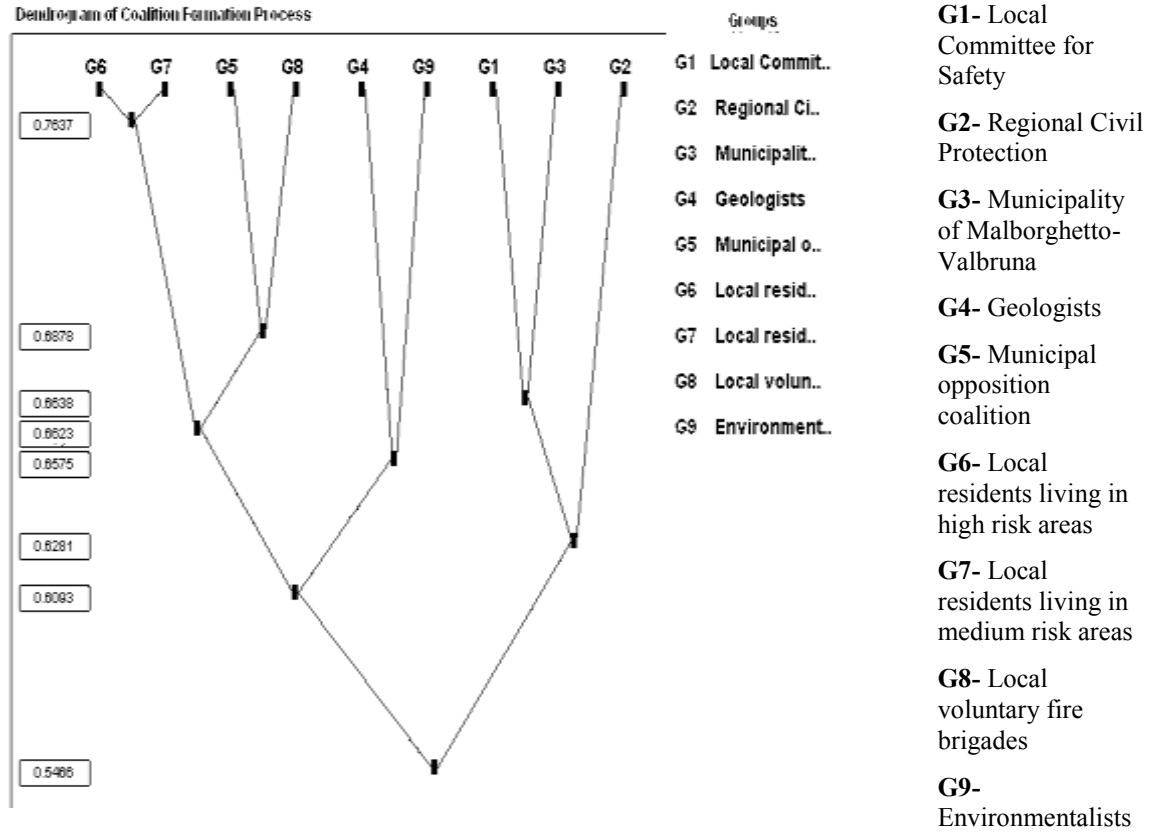
Table 4. Social Impact Matrix: assessment of scenario in view of each actor

SCENARIOS ACTORS	A- Preservation of the current situation	B- New protection hydraulic works	C- Relocation of part of the community	D- Monitoring and control activities	E- Integrated management/ local knowledge	F- Re-naturalisation of the river course
G1- Local committee for Safety	*****	*****	*	***	***	*
G2- Regional Civil Protection	*****	*****	**	*****	***	**
G3- Municipality of Malborghetto-Valbruna	*****	*****	****	***	***	**
G4- Geologists	**	*	*****	****	****	****
G5- Municipal opposition groups	**	**	****	*****	*****	****
G6- Local residents living in high risk areas (Ugovizza)	***	*****	*	*****	*****	***
G7- Local residents living in medium risk areas (Malborghetto)	****	*****	**	*****	*****	***
G8- Local voluntary fire brigades	***	****	****	*****	*****	****
G9- Environmentalists (regional level)	**	*	*****	***	****	*****

Once introduced in the NAIAD software, the Social Impact Matrix allows to visualise the Dendrogram of Coalition Formation, which structures the information and theoretically pictures the coalitions which might be established amongst social actors according to similarities in their opinions. In order to do this, NAIAD calculates semantic distances⁸ between each pair of interest groups, which is a measure of similarity (i.e. the more agreements about the ranking of different scenarios, the less semantic distance between these two interest groups). The Dendrogram for the case in Malborghetto-Valbruna is shown in Figure 2.

⁸ The semantic distance between *i* and *j* (two different stakeholders) is calculated as the Minowsky distance between the two elements.

Figure 2. Dendrogram of Coalition Formation Process.



As a result, three main coalitions arise: proponents of structural works (G1, G2 and G3); advocates of non-structural approaches (G4 and G9); and supporters of holistic approaches and the integration of local knowledge (G5, G6, G7 and G8). This last cluster is divided in two sub-clusters: one formed by the local people (whether in high or medium risk areas) and another by their non-technocratic representatives (fire brigades and political opposition groups).

5. Social Actors' Narratives and value dilemmas in flood mitigation

Values⁹ are shown to influence or determine several key aspects in research related to flood mitigation decision-making processes and outcomes (e.g. Morris-Oswald and Sinclair, 2005). Values related to safety, urban and economic development, environment are usually identified as key by social actors while confronting flood risk issues. Values are very often conflicting: for example, in the case of floodplain zoning and related urban constraints, individuals may need to evaluate the relative importance of personal freedom and private property rights on the one hand, and public safety on the other (Beatley, 1989; 1999). The following analysis of social actors' narratives focuses on value dilemmas and on those aspects that have not found an appropriate representation in the SMCE.

5.1. The safe development paradox

In Malborghetto-Valbruna the safety issue is one of the most deeply felt conflicts after the 2003 flood event, when geologists suggested the relocation of some dwellings, without finding an agreement with engineers and local administrators. The mayor and the members of the majority political party together with the Civil Protection engineers proposed the construction of new protection works, whereas the Safety Committee members demanded for more safety through the construction of other protection works and the maintenance of the existing ones. Their main argument can be summarised in the quote of a Committee members' interview: "the more the protection works, the safer we are".

The same need was expressed by the municipal opposition coalition, but using different arguments: they suggested that local and traditional knowledge could contribute to better decisions about safety, including a better understanding of the environment and its history. Similar perspectives were expressed by the voluntary fire brigades, preoccupied about the impact of new protection works in the river basin in the case of an emergency. They argued that in case of an extreme event, the works would paradoxically constitute a greater source of danger in case of failure. This contrasts with the results of the questionnaire survey which show that although protection works do not increase individual perceptions of safety, they are regarded as tangible symbols of protection for the community¹⁰ (see also Morris-Oswald and Sinclair, 2005).

Three core issues emerge from this debate:

- *Safety dilemmas*: between the two alternatives (relocation vs. new protection works), an old question in risk research becomes relevant: 'How safe is safe enough?' (Fischhoff *et al.*, 1978). This should be considered also with reference to 'safety distribution': some areas have been made safer than others thanks to

⁹ The term "value" has myriad definitions, including both the idea of value as a material expression of worth and values as moral, ethical, social and spiritual belief systems that influence behaviour (Satterfield *et al.*, 2000). In this paper values are intended as a category of "beliefs", more specifically "evaluative beliefs" which are used to judge whether an action, an objective or an alternative is good or bad compared to others (Rokeach, 1973). A consisting body of literature explains the role of value systems on the development of actors' perspectives toward a social problem. There is a relationship between values and how people collectively address problems, form expectations and interpret facts and events (e.g. Beatley, 1999; Chong, 2000; Gregory, 2002; Guerrier *et al.*, 1995; Norton and Steinmann, 2001).

¹⁰ More than a half of respondents (52%) agree (4 or 5 on a five point Likert scale) with the statement "protection works provide a feeling of security to residents".

the construction of protection works, which was due to the Local Safety Committee lobbying action.

- *Safe development paradox*¹¹ and *protection works' failure*: some actors fear the failure of protection works, because it could multiply damage in the case of extreme flood events. They insist on the importance of residual flood risk (that remains despite the adoption of flood prevention and control policies) and emphasize the need to inform residents about it.
- *Civic involvement*: the lack of information to residents (e.g. before the implementation of new plans about protection works) and the lack of community involvement in decision making are deemed negative by the majority of actors. Some criticize the use of a technocratic top-down approach, which reduced the possibilities for citizen participation.

5.2. Floodplain zoning and limit to urban/economic development

Floodplain zoning and regulations have an impact upon urban development and economic growth. Displaying risk levels through floodplain zoning is subject to uncertainties concerning hydrogeological factors and is also related to the consequences of adoption of the risk maps (and relative urban constraints) for the community. Social actors with strong economic or urban development interests tend to ask for the reduction of constraints, while those responsible for the safety of the communities tend to avoid the liabilities from extreme flood events. Contradictions between perceptions about constraints and economic development plans abound in flood prone areas¹², and this was the case also in Malborghetto-Valbruna. Here areas where building was not allowed in the past were put to use after the construction of new protection works: for instance, urbanisation was allowed in some areas where there are records of landslides in the past. On the contrary, the new zoning prevent the development in areas where it was allowed in the past. In practice, this resulted in newly built areas that are more vulnerable to extreme events and economic decline in the neighbourhoods where urban development was restricted.

Moreover, those who were relocated after the 2003 flood experienced an increase in their new properties' value because they were located in areas designated as safer. As a result of this equity problem, the political minority coalition expressed concerns about the potential negative impacts of flood risk on attracting new investors and the need to create job and business opportunities for young people. The underlying assumption was that the investment of resources in economic development goals is strictly connected to the demographic community survival.

This argument was strongly criticized by regional environmentalist groups. They argued that the decisions taken by the responsible authorities promoted the development of individual industrial and commercial activities without an integrated vision of sustainable development for the whole valley. In this context, local administrators and geologists in charge of floodplain zoning were highly concerned with personal

¹¹The "safe development paradox" refers to the fact that protection works do not guarantee total safety for the community and in the case of extreme events they might turn into sources of danger (Burby, 1998; 2006; Enserink, 2004; Handmer, 2001).

¹² Pidgeon (2005) for instance, shows that development plans in France include areas which are simultaneously designed as high risk and fit for new industrial installations.

responsibility issues in risk levels' display and with accusations of inequities in their decisions about relocation.

In summary, the main dilemmas in floodplain zoning are the following:

- *Perceived incongruence in floodplain zoning*: The new floodplain zoning after the construction of protection works is perceived as incongruent by some residents and investors causing conflicts with local administrators and geologists in charge of risk levels' display.
- *Floodplain zoning and economic growth*: Discrepancies between decisions about constraints and economic development can be found. On the one hand, decision-makers are pressed by some residents and investors to reduce risk areas due to economic and urban development interests. On the other hand they are also liable for community safety. The presence of different non-equivalent descriptions of reality and social incommensurability (Munda, 2004; 2005) results in different definitions of what are constraints to development and how decisions about constraints should be taken.
- *Equity in risk distribution*: because the distribution of risk influences household economies through the modification of house prices, the increase of risk levels in some areas have created deprived groups of individuals living in an area defined as unsafe, while the value of their properties decreases.

5.3. Rivers' renaturalisation and maintenance of the territory

Natural resources management is another issue characterised by extremely different value orientations. In Malborghetto-Valbruna, environmentalists consider the restoration of the old river bed and the research for more space for streams and rivers as the main priorities for the floodplain management. In policy making, they argue, social constraints can be modified, but natural constraints are given. This objective is not easily compatible with development priorities of the other actors. This is explicit in the (same) residents' concerns about being relocated if the streams are renaturalized. They criticize environmentalists saying that this extreme solution could also result in disastrous consequences: for instance, the negative consequences of the 2003 flood have been exacerbated by the accumulation of debris along the river bed, a consequence of recent environmentalists' conservation policies. Other local actors oppose conservation policies for similar reasons, citing the evidence from past territory maintenance practices, which also facilitated its control and monitoring.

In their proposal for re-naturalisation, environmentalists have met opposition from different other actors. Although this issue seems to be "only" about the relocation of local inhabitants, the conflict has originated from the existence of different understandings and beliefs about what is nature, and what should be the relationship between nature and humankind.

In this case there is one main dilemma: the existence of conflicting scenarios about ecosystem integrity. The decision to entirely preserve the river environment is considered as something far away from local styles and traditions of dealing with territory maintainance.

6. Discussion

The application of both SMCE and Narratives Analysis has contributed to understand the Malborghetto-Valbruna case and it may provide some indications about how to better deal with flood mitigation conflicts.

The Impact Matrix elaborated in SMCE has proven an useful tool for flood mitigation. As we have seen, it may be used to elaborate a ranking of scenarios according to different criteria. However, its main value is the elicitation of the advantages and disadvantages of each scenario, accordingly to each indicator. This should be used not as a one-off tool, but rather as an iterative one, which could be improved also through the actors involvement, as in other cases of SMCE application (e.g. Gamboa, 2006; Munda, 2004). In the Malborghetto-Valbruna case, the Impact Matrix allows for the depiction of the multiple languages of valuation that may be used to justify the management of a floodplain. Because different criteria would ensure different recommendations, the Impact Matrix explicitly shows the trade-offs between scenarios. An interesting example is alternative C (“Relocation of part of the community”), which would have very positive environmental results, and it would also resolve the conflict over flood mitigation altogether, by taking the people out of the risk zone. However, as the Impact Matrix shows, this option is difficult to realise, because it has unacceptable social and economic costs. NAIADe offers a ranking of alternatives, which may guide the decision-making process. However, it is important to consider and use SMCE as a procedural tool that guarantees the transparency of the process, rather than a technocratic tool providing one single best solution.

The Dendrogram of Coalitions complements the analysis done in the Impact Matrix. It is a representation tool that puts in evidence the potential power alliances between different groups of actors and shows whether some scenarios are isolated owing to the lack of power of determined actors. In the Malborghetto-Valbruna case, the Dendrogram shows three main groups: those who privilege the construction of the hydraulic works, those who prioritise environmental criteria and those who defend the development of an integrated plan of control able to integrate all the scenarios. In this case we see that the scenarios offered by the first two groups are those who generate the greatest opposition and division within the community and that produce the isolation of their proponents.

As we have seen above, SMCE is a useful tool for the management of floodplain conflicts. However, the analysis of narratives has shown that a single application of SMCE does not capture the richness of the floodplain conflict in Malborghetto-Valbruna. For instance, the examination of social actors’ narratives shows that:

- Some relevant value dilemmas remain unsolved independently of the chosen scenario (i.e. maintenance of the *status quo*, new protection works, relocation,...) such as how to deal with the safe development paradox or the trade-off between safety and economic development.
- Approaches to flood risk management (i.e. structural, non-structural, holistic, local knowledge based approaches) are adopted depending on the values of individuals and their particular strategies in the struggles for power at the local level. In practice most actors favour a combination of styles rather than a single one.
- Decision makers’ attitudes on flood mitigation deeply influence the other social actors’ preferences toward scenarios and criteria. The selection of one single scenario can impose a valuation narrative (and its rhetoric).

These observations suggest that scenarios should not be considered in isolation but in combination. Therefore, if management styles appear to be mixed within the social actors' narratives, then scenarios should be developed accordingly. Rather than defining separate scenarios according to separate management approaches, scenarios that present a balance between the different approaches would be more suitable in the Malborghetto-Valbruna case. From this it can be inferred that the analysis of narratives is a useful tool to improve the individuation of values and interests at stake in the institutional analysis and to redefine scenarios during the iterative evaluation process that characterises SMCE.

Narrative Analysis also contributes to the process of generating evaluation criteria, selecting indicators and impact scores. Some relevant decisions must be taken by the analysts during the process of criteria selection regarding the quantity and quality of criteria. During the fieldwork, social actors were asked about their needs and expectations and these suggested the relevant criteria for flood mitigation. However the different actors' criteria were too numerous and a selection process was necessary. In the meantime, some needs and expectations can not find an appropriate space as criteria. Consequently, comparing the value and interest conflicts with the criteria shows that the selected criteria represent the views and priorities of some social actors better than others'. Moreover little research is carried out regarding the question how the preferences of social actors could be integrated properly in the multi-criteria evaluation. Not only the processes of criteria selection, but also the weighting highly influence the outcome of multi-criteria evaluation of risks. The question is also who exactly should participate in these processes and how: issues like legitimacy and equity arise from such questions..

Another issue to be considered in SMCE is the disagreements of the social actors about the extent and nature of the economic, social, and environmental impacts of each alternative. In this paper impacts have been determined accordingly to the judgements of the authors, based on their previous experience, the understanding of the Malborghetto-Valbruna case, the interviews to the social actors. However, this is clearly insufficient, as the analysis of narratives shows that there are discrepancies in the judgements about the nature of the impacts and their magnitude among the different actors. For instance, there may be disagreements about the magnitude of the visual impacts of the works: while residents living in medium-risk areas complain about the hydraulic works' visual impacts, citizens belonging to the Local Committee for Safety regard them as symbols of safety, which enable them to feel safe in their daily lives. Moreover stakeholders may also disagree about the relevance of the impacts.

How can these differences be fully addressed without resorting to experts and administrators, in an effort to include the local social actors in the SMCE process? Some scenarios are open, but need testing in practice. A possible solution could be the elaboration of different impact matrixes according to the preferences of each actor and develop an algorithm which could enable us to balance the different scenarios. However, this alternative has several shortcomings which could be object of further research such as the development of the algorithm; the balance of impact matrix when actors select different criteria; or the compatibility and representativity of the results. Implementing this solution would add a considerable degree of complexity to the SMCE, taking the researchers away from their main objective of finding a decision-making procedure that compromises between simplicity and representativity. Establishing a single impact matrix in SMCE implies the reduction of multiple perspectives and understandings down to a reduced list of simple and measurable

criteria. Whereas this may be an unavoidable step in SMCE, researchers must be aware of this shortcoming and act accordingly when presenting the results to local stakeholders.

Finally the study of narratives has shown that the social actors may form unexpected coalitions depending on a number of factors. An interesting example is that of the Local Committee for Safety, which does not form a coalition with the Municipal Authorities but rather with the Civil Protection Services. This seems to contradict the results of the Dendrogram obtained in SMCE, in which the three social actors seem to be closely linked. A crucial issue that separates the Local Committee for Safety and the Municipal institutions is the compensation benefits distributed after the flood event. This gives us an important insight about SMCE: the analysis of coalitions is based only on their positions with respect to one situation, in this case the future scenarios for flood mitigation. However, narratives analysis shows that, in practice, coalitions are dependent on several other factors which may not be directly linked to the problem studied in the SMCE. While the method may not be suitable to analyse the complexity of the social structure in the area of study (i.e. social networks' system, coping mechanisms and solidarity between different groups, social cohesion, etc.) it is important to recognise the possible alliances between actors and to acknowledge that these alliances, as well as any of the interactions occurring within the community, may not be directly linked to the problem under study.

7. Conclusion

The case of Malborghetto-Valbruna illustrates the existence of unresolved dilemmas and conflicts related to flood management and mitigation issues. These are represented, among others, by the problem of the safe development paradox and protection works' failure, the perceived incongruence in risk levels' display, the trade-off between safety and economic growth, the equity issues in risk distribution. Fuelled by these dilemmas, a fruitful debate has emerged in Malborghetto-Valbruna, sometimes transformed in an open conflict around the main flood mitigation issues and options. SMCE can help to mediate between the actors and to envisage new flood mitigation policies.

The case study suggests that the analysis of narratives is a useful tool to complement SMCE. This analysis enabled us to identify future routes for a better SMCE of the scenarios in Malborghetto-Valbruna, and it also unveiled some of the shortcomings of SMCE. This evaluation could be enhanced by:

- Improving the definition of scenarios according to both social actors' perspectives and the main value dilemmas at stake, which are not always appropriately represented by the criteria used in SMCE;
- Acknowledging the limitations in the evaluation of the impacts. For instance, social actors might establish thresholds of "non-acceptable impacts";
- Unveiling the differences between social actors that *a priori* seem to share the same attitudes toward flood mitigation scenarios.

SMCE addresses one of the main problems confronted in Natural Resources Management; the existence of different languages of valuation, that is, different outlooks on what this management should achieve and how. The strength of SMCE is its capacity to simultaneously represent these languages of valuation. However, it is important to reflect on the limitations that this social incommensurability poses for both SMCE and Narrative Analysis. The use of particular procedures such as matrixes, weights, vetoes and even surveys or workshops influence which languages of valuation

are more powerful in the decision making process. While SMCE opens the door for the inclusion of as many perspectives as possible, it is important to elicit all the assumptions used by the analyst(s) in an effort to avoid the decision-making process to be captured by a particular valuation language.

A similar issue influences the construction of the Social Impact Matrix: most of the actors adopt a single language of valuation in confronting with different strategies for action. As a result, the Social Impact Matrix appears to reflect a community where everybody has a clear agenda and fixed objectives and where middle grounds are almost unattainable. In practice however, actors may hold different languages of valuation simultaneously and their perspectives may be dynamic through time. For instance, local residents stress the importance of preserving natural resources but also see economic growth as a priority. Their choices of a scenario(s) would be dependent on the particular conditions in which they make such a choice and, crucially, on how the scenarios are presented to them. The comparison of the narrative analysis and SMCE has also shown some of the aspects of SMCE which could be enhanced through further research: in particular the difficulties to address different interpretations of the relevance of criteria and the importance of developing SMCE in the local context of decision making.

References

- Bana e Costa C A, Antao da Silva P, Nunes Correia F, 2004, "Multicriteria evaluation of flood control measures: the case of Ribeira do Livramento" *Water Resources Management* **18** (3) 263–283
- Beatley T, 1989, "Towards a moral philosophy of natural disaster mitigation" *International Journal of Mass Emergencies and Disasters* **7** (1) 5–32
- Beatley T, 1999 *Ethical dilemmas in hazard mitigation* (DIANE Publishing Co., Darby, PA)
- Burby R, 1998 *Cooperating with Nature. Confronting Natural Hazards with Land-use Planning for Sustainable Communities* (Joseph Henry Press, Washington D.C.)
- Burby R, 2006, "Hurricane Katrina and the paradoxes of government disaster policy: bringing about wise governmental decisions for hazardous areas" *Annals of the American Academy of Political and Social Science* **604** (1) 171–191
- Chong R, 2000 *Rational lives: norms and values in politics and society* (University of Chicago Press, Chicago)
- De Bruijn K M, 2005 *Resilience and flood risk management* (Delf University Press, Delft)
- De Marchi B, Funtowicz S O, Lo Cascio S, Munda G, 2000, "Combining participative and institutional approaches with multicriteria evaluation. An empirical study for water issues in Troina, Sicily" *Ecological Economics* **34** (2) 267–282
- De Marchi B, Scolobig A, Delli Zotti G, Del Zotto M, 2006 *Risk construction and social vulnerability in an Italian Alpine Region* Draft Report of the task 11 of the Floodsite research project, <http://www.floodsite.net> (last accessed: June 2006)
- Enserink B, 2004, "Thinking the unthinkable- the end of the Dutch river dike system? Exploring a new safety concept for the river management" *Journal of Risk Research* **7** (7-8) 745 –757
- Fischhoff B, Slovic P, Lichtenstein S, Read S, Combs B, 1978, "How safe is safe enough? A Psychometric study of attitudes towards technological risks and benefits" *Policy Sciences* **9** (1) 127–152
- Fordham J, 2000, "Participatory Planning for Flood Mitigation: Models and Approaches", in *Floods* (vol.II) Ed D J Parker D J (Routledge, London) pp 66–79
- Gamboa G, 2006, "Social multi-criteria evaluation of different development scenarios of the Aysen region, Chile" *Ecological Economics* **59** (1) 157 –170
- Gamboa G, Munda G, 2007, "The problem of windfarm location: a social multi-criteria evaluation framework" *Energy Policy* **35** (3) 1564–1583
- Green C H, Parker D J, Tunstall S M, 2000, *Assessment of Flood Control and Management Options* Thematic Review IV.4 prepared as an input to the World Commission on Dams, Cape Town, <http://www.dams.org> (last accessed: June 2006)
- Gregory R, 2002, "Incorporating value trade-offs into community-based environmental risk decisions" *Environmental Values* **11** (3) 461–488
- Gregory R, Wellman K, 2001, "Bringing stakeholder values into environmental policy choices: a community-based estuary case study" *Ecological Economics* **39** (1) 37–52

- Guerrier Y, Alexander N, Chase J, O'Brien M, (eds.) 1995 *Values and the Environment* (Wiley, Toronto)
- Gunderson L, Holling C, Light S, 1995 *Barriers and bridges to the renewal of Ecosystems* (New York: Columbia University Press)
- Hämäläinen R, Kettunen E, Marttunen M, Ehtamo H, 2001, "Evaluating a Framework for Multi-Stakeholder Decision Support" *Water Resources Management* **10** (4) 331–353
- Handmer J, 2001, "Improving flood warnings in Europe: a research and policy agenda" *Environmental Hazards* **3** (1) 19–28.
- Haque C E, Kolba M, Morton P, Quinn N, 2002, "Public involvement in the Red River Basin management decisions and preparedness for the next flood" *Environmental Hazards* **4** (2) 87–104
- Janssen R, Munda G, 1999, "Multi-criteria methods for quantitative qualitative and fuzzy evaluation problems", in *Handbook of environmental and resource economics* Ed J Van den Bergh (Edward Elgar Publishers Cheltenham)
- Kiker G A, Bridges T S, Varghese A, Seager T P, Linkovjj I, 2005, "Application of Multicriteria Decision Analysis in Environmental Decision Making" *Integrated Environmental Assessment and Management* **1** (2) 05–108
- Messner F, Meyer V, 2006, "Flood damage vulnerability and risk perception – challenges for flood damage research", in *Flood Risk Management – Hazards Vulnerability and Mitigation Measures* Eds Jochen Schanze Evzen Zeman Jiri Marsalek (NATO Science Series Springer Publisher) pp 149–167
- Morris-Oswald T M, Sinclair A J, 2005 "Values and floodplain management: Case studies from the Red River Basin Canada" *Environmental Hazards* **6** (1) 9–22
- Munda G, 2004, "Social multi-criteria evaluation (SMCE): methodological foundations and operational consequences" *European Journal of Operational Research* **158** (3) 662–677
- Munda G, 2005, "Multiple criteria decision analysis and sustainable development" in *Multiple-criteria decision analysis State of the art surveys* Eds Figueira J, Greco S, Ehrgott M (Springer International Series in Operations Research and Management Science New York) 953–986
- Mustajoki J, Raimo P, Hämäläinen R, Marttunen M, 2004, "Participatory multicriteria decision analysis with Web-HIPRE: a case of lake regulation policy" *Environmental Modelling & Software* **19** (4) 537–547
- Nijkamp P, Vos J B, 1977, "A Multicriteria Analysis for Water Resource and Land Use Development" *Water Resources Research* **13** (3) 513–518
- Norton B G, Steinemann AC, 2001, "Environmental values and adaptive management" *Environmental Values* **10** (4) 473–505
- Pearce L, 2003, "Disaster management and community planning, and public participation: how to achieve sustainable hazard mitigation" *Natural Hazards* **28** (2-3) 211–228
- Pidgeon P, 2005, "From structural to systemic: proposal to make French flood management more consistent" paper presented at: *Major risks challenging publics*

scientists and governments Society for Risk Analysis Europe Annual Meeting Milano, <http://www.sraeurope.org/> (last accessed: June 2005)

Rasid H, Bimal K P, 1987, "Flood problems in Bangladesh: Is there an indigenous solution?" *Environmental Management* **11** 2: 155 – 173

Rokeach M, 1973 *The nature of human values* (The Free Press, New York)

Satterfield T, Slovic P, Gregory R, 2000, "Narrative valuation in a policy judgment context" *Ecological Economics* **34** (4) 315–331

Schanze J, 2006 "Flood risk management. A basic framework" in *Flood Risk Management – Hazards Vulnerability and Mitigation Measures* Eds Schanze J, Zeman E, Marsalek J (Berlin et al) pp 1–20

Simonovic S P, 2005, "Sustainable floodplain management-participatory planning in the RED RIVER BASIN – Canada" paper presented at: *Workshop on Modelling and control for participatory planning and managing water systems*, Venice. http://www.elet.polimi.it/IFAC_TC_Environment/Venice2004/ (last accessed: June 2006).

Stirling A, 2006 "Analysis, participation and power: justification and closure in participatory multi-criteria analysis" *Land Use Policy* **23** (1) 95-107

World Commission on Dams WCD, 2000 *Dams and development: a new framework for decision-making*, <http://www.dams.org/> (last accessed: June 2006).